Washington Water Power Company Monroe Street Plant, Generating Units 4 and 5 **HAER No.** WA-29
South bank of Spokane River, directly below the Monroe Street Bridge
Spokane
Spokane County
Washington

HAER
WASH,
32-SPOK,
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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Western Region
Department of Interior
San Francisco, California 94102

HAER
WASH,
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HISTORIC AMERICAN ENGINEERING RECORD
WASHINGTON WATER POWER COMPANY
MONROE STREET PLANT: GENERATING UNITS 4 AND 5

HAER No. WA-29

Location:	Washington Water Power Company Monroe Street Plant, Generating Units 4 and 5, South bank of Spokane River, directly below the Monroe Street Bridge, Spokane, Spokane County, Washington Accessed from the Municipal Building (City Hall) on West Spokane Falls Boulevard via a ca. 0.25 mile private gravel-surfaced maintenance road. U.S.G.S. 7.5 minute series, Spokane NW quadrangle, Universal Transverse Mercator coordinates: 11.468040.5278440
Date of Construction:	Installed 1903
Engineer:	Unknown
Builder:	General Electric Company
Present Use:	Hydroelectric power generation; to be replaced by 1992
Significance:	Installed in Washington Water Power Company's (WWP) Monroe Street Plant in 1903, Generating Units 4 and 5 are believed to be the oldest turbine-generator units still operating in the State of Washington. The two alternating current (AC) generators exemplify technological development of early twentieth century hydroelectric potential and long-distance power transmission. Installation and operation of the generating units dramatically influenced progress and growth of manufacturing and mining in eastern Washington and northern Idaho. Generating Units 4 and 5 were determined eligible for inclusion in the National Register of Historic Places in 1983.
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MONROE STREET PLANT DESCRIPTION

When the Monroe Street Plant began generating electricity in the early 1890s, WWP provided limited service to a population of approximately 23,000 residents in the rapidly growing frontier city of Spokan Falls (the name was later shortened to Spokane and an "e" added to the name). Construction of the Monroe Street Plant began in 1889, and in 1891 work commenced on the rock crib Monroe Street Dam, located ca. 200 feet upstream from the Plant. In November of 1891 the new system came on line (Blewett 1989:8). By 1903 Spokane had nearly doubled in population to almost 45,000 residents. In keeping with such dramatic increases in consumer demand, WWP purchased Generating Units 4 and 5 (which then represented the most advanced hydroelectric equipment of the time) from the General Electric Company. The units were lowered into place in 1903 and still occupy their original positions in the Monroe Street Plant today. Generating Units 4 and 5 are believed to be the oldest operating turbine and Alternating Current (AC) generators of their type in the state, and were determined eligible for inclusion in the National Register of Historic Places in 1983 (David M. Hansen letter to Roger Woodworth, 12 October 1983).

Following construction of the Monroe Street Plant in 1891, a facility which was then served by two steel penstocks, subsequent expansion of the plant in 1903 included installation of additional penstocks (see photo WA-29-18) and an expansion of the powerhouse building (see photos WA-29-22-24). In 1972, owing to deterioration of the aged Monroe Street Plant, WWP renovated the plant. During the two year renovation, the 1891 building (labeled "original section" in photo WA-29-22) was razed. First used to house Direct Current (DC) generating apparatus, the original structure had become obsolete with conversion to AC power. About two-thirds of the later expansion (labeled "Newer Section" in photo WA-29-22) was removed during renovation. The newer section houses the present five turbine-generator units, including Generating Units 4 and 5. After renovation, only about one-half of the north wall of original brickwork remained intact (the wall once shared in common by the original building and the later expansion). Renovation included new flooring, roofing, and extensions to the present building (newer section), in addition to construction of new east, south and north walls. In order to compliment existing historic buildings in the vicinity, the Monroe Street Plant was reconstructed to reflect the character of early 1900s architecture (*Spokesman Review* 1 January 1903:B-1; "Request for Determination of Eligibility," with letter from Roger Woodworth to Lisa Soderberg of 24 June 1983; Roger Woodworth, telephone conversation with the author 6 August 1990).

At the same time renovation of the Monroe Street Plant was underway, the original Monroe Street Dam, which had been severely damaged by high water in 1971, was replaced by a new concrete dam located 48 feet downstream of the original dam site, as shown in photo WA-29-19 ("Request for Determination of Eligibility" 24 June 1983; Hansen 12 October 1983). The function of the new dam is to divert water through a penstock to the Monroe Street Plant's generating equipment, rather than creating a storage reservoir (WWP, "Application for Amendment of License to Redevelop the Powerhouse of the Monroe Street Hydroelectric Development of Spokane River Project No. 2545" 1990:14).

Today, the Monroe Street Hydroelectric Development is part of WWP's Spokane River Project, which includes five power developments. Current generating capacity of the Spokane River Project is 114 megawatts, about fifteen percent of WWP's total hydroelectric production capacity. Originating from the peaks of the Bitterroot Mountains, and emptying into Coeur d'Alene Lake in Idaho, the project encompasses a drainage area of 4,290 square miles upstream of the Monroe Street Plant. The lake outflows into the Spokane River, the source of water for the Monroe Street Plant. Water levels in Coeur d'Alene Lake partially regulate river flow through the Monroe Street Plant and the concrete overflow Monroe Street Dam. The dam will not be altered by the redevelopment project (WWP, "Application for Amendment" 1990:11,13,E-3).

GENERATING UNITS 4 AND 5

Each of the two Generating Units 4 and 5 is comprised of a Stillwell-Bierce 4,000-h.p. turbine and a General Electric AC 4,000-volt, ATB-type generator. They stand at the east end of the Monroe Street Plant, with Unit 5 nearest the east wall and Unit 4 immediately to the west (see photo WA-29-20). Units 4 and 5, like the other three generating units to the west, are installed horizontally and aligned perpendicular to the flow of the river (see photo WA-29-19).

Turbines 4 and 5 are different from the three other turbines in the plant in that they (4 and 5) have two water wheels, or "runner blades," while the other units have single blades (see photos WA-29-28). The direction and force of rushing water entering an outer chamber is controlled by two metal sleeves on Units 4 and 5; wicket gates serve the same function on the other turbines. Gate motors operate the sleeves on 4 and 5 (see photo WA-29-8), replacing earlier hydraulic governors.

Generators 4 and 5 are essentially machines that convert mechanical energy to electrical energy. Their main components include copper conductors mounted in a stationary housing called a stator, and a rotor which rotates a magnetic field. AC current is produced in that manner, that is by rotating the field over stationary conductors; the opposite is true in Direct Current (DC) units, which produce current by rotating conductors over a stationary field. In Generator Units 4 and 5, as in all AC units, the conductors are arranged to form a circuit in which the voltages are generated in the same direction, thus producing electric current.

At present, Unit 5 is the second least efficient component (behind Unit 2) in the plant, producing 1.07 megawatts (MW) of power. Unit 2 produces the least, at 0.84 MW. Unit 4 delivers 1.25 MW, slightly less than Unit 3 (1.37 MW). Unit 1 has been disconnected and is being disassembled. Power generated at the Monroe Street Plant travels via two cable feeder lines eastward uphill to WWP's Post Street Substation, from where the load is distributed. Standing majestically above the lower falls created by the dam serving the Monroe Street Plant, the station on Post Street occupies a commanding position in the downtown Spokane central business district. Appropriately, the substation is one of the city's most stylish industrial structures, having been designed by famed architect Kirtland Cutter.

Other ancillary equipment in the Monroe Street Plant function in conjunction with, and facilitate the operation of, Units 4 and 5. Current from the Units passes through oil circuit breakers mounted on the south wall (see photo WA-29-13). In cabinets below the breaker switches are interrupters, consisting of laminated wooden rods with metal conductors which, when lifted by the breaker switch, separate and allow oil to fill an enclosed chamber, thus breaking the circuit. Control panels on the upper level gallery at the west end of the building control and monitor volts, amperages, and other operational elements of the plant. Control mechanisms for Units 4 and 5 are encased in small black boxes with glass windows on grey polished marble panels near the south end of the gallery (see photo WA-29-12). Protective relay controls in the nearby Post Street Substation have made round-the-clock monitoring of the panels unnecessary, however. Removal and maintenance of all units is facilitated by an overhead movable crane (see photo WA-29-11), which travels the length of the building on rails running east/west above the generating room.

Between Units 4 and 5 are smaller belt-driven DC generators. Called "exciter units" (A and B), they provide "excitation voltage" in direct current to all five AC generating units in the plant (see photo WA-29-10). At present only Exciter A, installed between generators 4 and 5, is functioning. A belt connecting fly wheels mounted at the south ends of the drive shafts on the exciter and Unit 4 provide the motive force for Exciter A, which is a 250-volt Westinghouse DC generator (see photo WA-29-4). Exciter B, installed between turbines 4 and 5, is a 130-volt Westinghouse DC generator, but is not currently in service.

ALTERATIONS TO GENERATING UNITS 4 AND 5

(The following information describing alterations to Units 4 and 5 was provided by Bob Choate, Spokane Area Superintendent of Power Supply for WWP to Robin Bruce on 1 May 1990. Choate has worked for WWP for thirty-eight years and was present in the Monroe Street Plant when the alterations described below occurred).

Despite nearly nine decades of continuous use, only two alterations notably affected the original functioning of Power Generating Units 4 and 5. In both cases the alterations involved turbine control mechanisms, changes which were chiefly designed to increase machine efficiency and reduce labor costs.

The first alterations were completed on 3 January 1969, and involved modification of the gate control apparatus on Stillwell-Bierce turbines 4 and 5. Positioned in the circumferences of the turbine casings, the gates control the flow of river water from the penstocks into the turbine runners. The alterations consisted of replacing the gate governor on each unit with a 1.0-h.p., 130 Volt DC gate motor. The motor assemblies were salvaged from other company equipment, fabricated in-house by WWP mechanics, and attached to their present position in front of each turbine unit (see photos WA-29-6-8). The turbine governors on Generating Units 4 and 5 basically performed two functions: they brought the units up to synchronous speed and varied the speed of the units with changes of frequency. Typically, turbine governors are delicate, complex systems that are extremely sensitive to accumulations of dirt, the presence of which in even minute amounts can cause the whole system to fail (Creager and Justin 1955:1091). This tendency is attested to by former Monroe Street Plant operators, who state that the governors on Turbines 4 and 5 were consistently high maintenance mechanisms and were never very efficient nor very reliable. For example, the governors on both units were given to frequent sticking, both when the gates were wide open and when they were closed--extremes which resulted in high loss of machine efficiency. Although governor control capabilities were sacrificed when the gate motors were installed, the modifications increased overall plant efficiency.

In contrast to the complex governor assemblies, the new gate motors were of simple design. Parts were few and of standard make. They could easily be replaced or fabricated in-house. These advantages decreased maintenance requirements, and thus man hours spent servicing the turbine units. In addition, the gate motors improved control of generator speed by allowing for manual regulation of the amount of water flowing through the gates into the turbines. The gate motors further improved control, as well as advanced machine efficiency, by allowing the operator to shut the units down to "speed no-load," a condition where the units neither generate nor use power. The hand wheels on the gate motors (see photo WA-29-6) also maximized control by enabling the operator to physically close the water wheels, thus completely shutting off water to the turbines.

In the mid 1970s Generating Units 4 and 5 were again altered. The modifications involved the main turbine bearing lubricating apparatus. The original internal lubricating systems for both turbine units contained brass "slinger rings," each ca. 14 inches in diameter, fitted around their respective turbine generator shafts. As the shafts turned the slinger rings dipped into oil reservoirs below the bearing units, repeatedly bathing the shafts with oil.

In order for the plant operator to monitor the lubricating system, the original turbine design featured recessed "dog holes" to provide inspection access to the slinger ring lubricating systems. The dog holes measure ca. 3.0 feet in diameter and are recessed ca. 5.0 feet into the turbines' housing directly above the main turbine shaft bearing unit (see photo WA-29-9). On the dog hole floor, two "sight glasses" located above the bearing unit allowed for visual inspection of the lubricating apparatus, and oil levels. Checked hourly, the dog hole inspections were a time consuming, awkward process. The installation of the new gravity flow lubricating system streamlined and simplified the lubricating system. Most notably, the innovation allowed for the removal of the slinger lubricating rings, thus eliminating maintenance parts which were chronically subjected to extreme pressure and friction. The new gravity flow system provided a steadier, more dependable supply of oil to the bearing, reduced maintenance potential, and facilitated more efficient monitoring of the system by the station operator. The present lubricating system for Turbine Units 4 and 5 consists of a ca. 70 gallon oil storage box mounted ca. 6.0 feet above the maintenance cat walk on the plant's north wall. The oil flows from the storage box through ca. 0.25 inch tubing, which is accessed to the bearing units through the former sight glasses on the dog hole floor. Gravity force assures a steady drip from the oil feeder tubing onto the bearing unit. New sight glasses and regulating valves installed on the oil feeder lines allow the operator to monitor the system from the maintenance catwalk, rather than from the cramped dog hole, as with the old system. Oil not utilized by the turbine bearing flows from the oil box through overflow pipes, and passes through a filtering system into a sump beneath the bearing unit on each turbine. Directly above the oil sumps, 1.0-h.p. electric motors pump the oil back through return pipes to the oil storage box, thus constantly recirculating the lubricating oil. Because the oil is circulated at low speed and is not subjected to heat, oil contaminants are minimal. According to station operators, except for adding small amounts of oil to the system to compensate for minor leakage, the oil in the system has not been changed since the system was installed fifteen years ago. In fact, the system was so successful at the Monroe Street plant that WWP mechanics subsequently installed the same apparatus to the turbine/generator units at WWP's Post Falls, Nine Mile, Long Lake, and Little Falls plants.

In sum, replacing the turbine governors with gate motors and installing the gravity flow lubricating system were alterations that satisfied objectives of WWP administrators in realizing more efficient, cost-effective management of the Monroe Street Plant. Ultimately, the combination of these simple alterations eliminated the need for two full-time operators at the Monroe Street Plant.

SITE DESCRIPTION

The Monroe Street Plant is in the heart of downtown Spokane, Washington, the largest city in eastern Washington (population 170,200), the commercial, manufacturing, and transportation hub of the Inland Northwest (U.S. Government Documents, Washington State, "County and Community Profiles" 1988:Spokane-1). The Monroe Street Plant is situated on the south bank of the Spokane River immediately east of the south tower of the main arch of the Monroe Street Bridge, constructed 1911 (see photo WA-29-1). Adjacent to the Plant's west end the bridge's central "Great Arc" curves 281 feet overhead to the river's north shore (Barber 1984:5). The acclivity above the Monroe Street Plant is extremely steep, overgrown with both domestic and wild shrubbery and vegetation, and characterized by precipitous rock outcroppings.

Beginning with white settlement (early 1870s), and continuing to the present day, commercial-industrial development at the falls has proceeded virtually non-stop. This ongoing process has resulted in almost one-hundred percent ground disturbance in the area, and has altered nearly all of the landforms in the vicinity of the Monroe Street Plant. Earth and debris fill covers a gully once containing a small stream above (south of) the present Monroe Street Plant where Indians may have camped while fishing (see paragraph 3, page 8). However, the area has lost any physical record of prehistoric Native American use and occupation that may once have been present.

Cultural remains in the area dating to the historic period are situated on the steep hillside above (south of) the Monroe Street Plant. The hillside itself is a cultural feature, consisting primarily of debris from the great fire that destroyed nearly all of downtown Spokane in August 1889. After the fire, townspeople filled the gully below what is now the hillside with building debris, creating the landfill on which the western ends of Spokane Falls Boulevard (west of City Hall) and Main Avenue (west from Post Street) now lie (Hyslop 1983:136). Today, fragments of concrete and rusted metal, rotted timbers, and slag-like cinders either from furnaces or the 1889 fire litter the hillside.

Other structural remains on the hillside were obviously constructed there. A rusted chain link fence and sprinkler pipes, located directly below the present viewpoint just north of the sidewalk on Spokane Falls Boulevard and west of City Hall, were part of the old Huntington Park (now overgrown). Situated near the top of the hillside, southeast of the Monroe Street Plant, the park was named for former WWP President David Lynde Huntington, and was first dedicated in the early 1950s (WWP "Application for Amendment of License" 1990:51). Amongst debris and stone retaining walls lie rusted metal cables and rotted wood poles, possibly associated with early electrical transmission lines from the original Monroe Street Plant, the southern portion of which was razed in the 1970s (see paragraph 3, page 14).

More substantial remains of WWP's early power transmission network occupy the hill behind (south) of the plant. Two concrete and brick cable ducts run parallel a few feet apart east-to-west from the foot of the hillside behind (south of) the concrete deck off the south side of the present plant, and continue uphill to the plant's access road entering the area from behind City Hall. Brick cable duct houses, some round and some square, containing square clay ducts and a few remnant electrical cables are spaced periodically along the cable ducts. Erected in 1903, the structures carried high voltage electricity to rich silver and lead mines in the Coeur d'Alene Mining District, located 110 miles to the northeast (*Spokesman-Review*, 1 January 1903:B-1). At least six of the brick structures stand on the hillside, the largest rising over 10 feet above the ducts, the smallest are nearly flush with the tops of the ducts. Most have flat concrete roofs consisting of three heavy hinged metal sheets allowing access to cables passing through the ducts.

The Spokane World's Fair, Expo '74, encompassed an exhibition area that included WWP's property on Havermale and Canada islands directly east of the Monroe Street Plant (the present Riverfront Park). At that time, recreational opportunities were also created in the vicinity of the Monroe Street Plant. In 1972, WWP landscaped the river's south bank between the Monroe Street dam and the Monroe Street Plant. Today, the area offers concrete walkways and river overviews for pedestrian sightseers. Overhead, the Riverfront Park Gondola rides afford visitors breathtaking views of the Spokane River Project and the lower falls. Public fishing (another recreational opportunity) is allowed from the shore in the vicinity of, and downstream from, the Monroe Street Plant ("Application for Amendment" 1990:44,50-52).

HISTORICAL BACKGROUND

Before white settlement (early 1870s), a large permanent village of the Upper Band of the Spokane Indians occupied both banks of the upper and lower (main) falls of the Spokane River, an area which today comprises the business center of metropolitan Spokane (Ray 1936:136). Prior to white encroachment, in addition to the Spokanes, native peoples of various tribal groups congregated seasonally at the falls, which was the upper limit of salmon migration on the river (Ray 1936:136; Ruby and Brown 1970:18). Soon after the first settlers began locating at the falls, many Indians formerly living along the river began relocating to Indian reserves. However, various bands continued to "rendezvous" at the falls for fishing and fish drying for several autumns following white occupation of the falls area (Glover 1985:38).

From modest beginnings, pioneer settlement at the main falls increased dramatically. In 1872, J. J. Downing, L. R. Scranton, and Richard M. Benjamin built a sawmill along the South Channel of the river above Spokane Falls. Shortly afterward, in May 1873, James N. Glover, the entrepreneur later known as the "father of Spokane," arrived at the falls and purchased the mill and 100 acres of land lying on both banks of the river (Edwards 1900:49-50; Work Projects Administration 1941:246). The mill was the first industrial installation in the City of Spokane. Glover later recalled that in those early days, "the entire town consisted of half a dozen board and log cabins, with a little shed that housed a sawmill" (Glover 1985:17-18).

Dedicated to founding a town (Glover platted the townsite of Spokane in 1878), he was particularly taken with the falls: "I was enchanted--overwhelmed--with the beauty and grandeur of everything I saw. I determined that I would possess it. I liked the falls, with their foundation of basaltic rock that would remain forever" (Glover 1985:20-21). Other settlers soon arrived. In the autumn of 1874, Samuel G. Havermale and his family preempted a homestead that included Havermale Island located directly upstream from the present Monroe Street Plant (Glover 1985:50). Together, Glover's and Havermale's properties eventually formed the nucleus of the WWP's initial hydroelectric efforts in the Pacific Northwest.

The falls which so impressed Glover had a power potential of roughly 30,000-h.p. However, until 1885 this force remained largely untapped. Before that time, the chief users of water power at the falls were industries which could most efficiently power their equipment by utilizing falling water, routed through primitive water wheels. For this reason, flour milling dominated economic development in early Spokane (WWP 1937:16). But technology was rapidly changing. In 1879 Thomas Edison invented the electric incandescent light. Just two years later, he installed the world's first generating station in New York City.

In 1885, only three years after Edison built his first power plant, George A. Fitch brought electrical generating equipment to Spokane. Fitch installed the apparatus in the basement of the Echo flour mill (Hyslop 1983:86). The generating equipment consisted of a four-dynamo, 25 kilowatt incandescent lamp system (Blewett 1989:3).

As Spokane grew, Fitch's enterprise attracted the interest of some of the city's early capitalists, who bought Fitch out and formed the Spokane Falls Water Power Company. On 18 April 1888, the company reorganized as the Edison Electric Illuminating Company of Spokane Falls. The Edison Company, as it came to be known, built a new power station, dubbed "No. 1," on the rock point now occupied by the WWP Post Street Substation, located immediately east of the present Monroe Street Plant. For the first time, twenty-four hour electrical service was provided to selected residential districts of the city. Generating four times the capacity of the earlier facility, the plant also powered the Spokane Street Railway (Crosby 1931:8; Fahey 1986:164; Hyslop 1983:89; WWP 1937:17).

Shortly after formation of the Edison Company, a group of local stockholders in the company formed a separate organization, The Washington Water Power Company (WWP). The originators of the company, F. Rockwood Moore, John D. Sherwood, H. Bolster, W. S. Norman, and Cyrus R. Burns authorized capital stock in the company of $1,000,000. WWP then moved to acquire a water power site located on the south side of the lower falls, an area later known as "Monroe Street" ("Reclassification of Electric Plants" 1937:19).

On 4 August 1889, the conflagration known to history as the Great Spokane Fire destroyed most of the original downtown of the booming pioneer city, which at the time of the blaze boasted a population of more than 20,000 inhabitants. The newly organized WWP records were among the documents destroyed in the blaze. Undaunted by the loss, the founders of the company formally reorganized on 1 January 1890 (WWP 1937:20). Following the fire, cleanup crews dumped debris from at least 296 buildings into the gully in the vicinity of the present Monroe Street Plant (Hyslop 1983:435). As discussed previously, this historic debris comprises part of the fill behind the Monroe Street dam.

Following the 1889 fire, demand for electricity increased dramatically as the town's spirited citizens began the task of rebuilding. In November of 1890 the Monroe Street Power Station began operations (WWP 1937:22). The facility was Spokane's first "modem plant," in that it utilized penstocks rather than open flumes to deliver water to the generating equipment (see photos WA-29-14-16). The penstocks took full advantage of the sheer drop below the Monroe Street Dam, a timber crib structure which WWP had constructed in the winter of 1889-90 (Hyslop 1983:333). Originally only two steel penstocks delivered water to the plant's turbines; eventually five above-ground penstocks would serve the facility (see photos WA-29-18-19). Six new Edison dynamos with 350 kilowatts of direct current (DC) came "on line" on 9 November 1890 (Hyslop 1983:333). Years later, James Glover visited the power house and compared it to the site as he first observed it in 1873:

> [I] went down to where the lower power house is now. A great rock protruded from the water, just opposite the whirlpool, and I climbed upon this and gave myself completely over to admiration and wonder at the beautiful, clear stream that was pouring into the kettle and over the falls.
>
> There were many more rocks in the river then than there are now, of course. When the Water Power Company put in the dam and power house, it blasted a great many of them out of the way (Glover 1985:19-20).

The DC (Direct Current) power generated at the plant was used to run the local streetcars and operate the city's arc lamps. In DC power systems, electromagnetic fields are stationery and conductors are moved, producing a stream of electrons flowing continually in one direction (Loew 1946:4,158). This method of power generation posed major difficulties for early hydroelectric producers, most notably in the limited capacity (typically very low voltage) of the DC generators, and in the inability of DC systems to transform current-power to higher or lower voltages, a necessity for practical and economical long-distance power transmission.

The refinement of AC power dramatically increased hydroelectric potential. AC power operates on the opposite principal of DC power in that the conductors are stationary and the fields are moved (Loew 1946:158). This arrangement enabled AC generators to deliver many times the kilowatt power of DC systems at less cost. Equally important, through the use of simple transformers (of which there are no counterparts for DC systems), AC systems could change alternating-current power at low voltage to a nearly equal amount of alternating-current power at high voltage. Since very high voltages had to be maintained to compensate for line loss over distance, refinement of this capability made long-distance transmission economically and technologically feasible for the first time (Loew 1946:302).

WWP assumed a leading role in the introduction of AC generating systems in the West, and in the development of long distance power transmission. Besides the challenge of keeping up with Spokane's booming population and rapid industrial growth, in large, incentive to develop AC power was spurred by WWP's desire to provide hydroelectric service to the Coeur d'Alene Mining District. The acquisition of Generators 4 and 5, each with a rating of 4,000 volts, were of paramount importance in servicing those lucrative consumer markets. In cultivating those markets, WWP not only proved themselves innovative pioneers in hydroelectric development and long-distance power transmission, but for years to come those pioneering efforts influenced broader themes, including growth of local manufacturing, town building, and the creation of jobs, locally and regionally.

Alternating current was first introduced in Spokane in 1892, when a 50-light Thomson-Houston arc machine and a 60 kilowatt AC generator were installed in the Monroe Street Station. However, by 1900 the outmoded system was deficient in handling WWP's increasingly sophisticated electrical needs (WWP 1937:23). In November of 1902, the need to update WWP's generating equipment to AC systems was addressed by WWP general manager, D.L. Huntington, in a letter to F.O. Blackwell of the General Electric Company (GE) of Schenectady, New York, the company which supplied generating equipment to WWP:

> We have been operating as you know, a plant consisting of the following classes of apparatus:
>
> Direct current, 3-wire Edison system;
> Direct current 500 v. Railway system;
> Alternating system 2080 v.
> Thomson-Houston series arc lighting system.
>
> On the completion of our new plant we will change our alternating system over to all 30 phase, 4-wire system - will discontinue the use of the direct current series arc system and substitute therefore for street lighting only the alternating arc system (WWP Papers, Series 7, Container 10, 20 November 1902, EWU Archives).

Eventually AC equipment replaced all the DC apparatus in the Monroe Street Plant. Units 4 and 5 were installed in 1903, Unit 3 was replaced in 1936, Unit 2 in 1937, and finally Unit 1 in 1948 (Woodworth 1983).

Early in November of 1902, Huntington wrote GE concerning shipping delays of the power generators and associated power transmission apparatus. The urgency of his tone indicates how crucial timely arrival of the equipment was in WWP's upcoming plans to service the Coeur d'Alene Mining District:

> Our contract for power in the Coeur d'Alenes are for July 1st.... It is of very great importance to us - we run great risk of having some of our power contracts canceled if not ready on time, and we cannot exaggerate the importance from our standpoint of having shipments made when promised (WWP Papers, Series 7, Container 10, 10 November 1902, EWU Archives).

On New Year's Day 1903, WWP announced its upcoming expansion plans, and described the benefits the project would bring to Spokane and the Inland Empire. D.L. Huntington was the author of the *Spokesman-Review* feature article:

> In the fall of 1901 the Washington [Water] Power company of this city began the construction of a power transmission line over 100 miles in length, to be operated at a pressure of 60,000 volts, for the purpose of transmitting power from Spokane to the rich Coeur d'Alene mining district in northern ldaho. This line is second only in length to the California Line mentioned above [the Bay Counties Power Company] and is to be as high or higher in pressure than any line now completed or under construction. The power will be generated by the falls of the Spokane River at Spokane and transmitted over three copper conductors or wires on a pole line built for the purpose.... [The] line runs east and north to the towns of Cataldo, Kingston, Kellogg, Osburn and Wallace, and from there...to Gem, Mace and Burke....It is intended to use this power for lighting the mines and buildings and towns along the line. It will be used principally, however, for motive power for driving air compressors, turning mills and concentrators, for pumping, hoisting, sawing out timber: to operate electric locomotives for hauling ore; for driving fans and large and small motors of every description, and for the multifarious needs of a large mining property.... It is estimated that the advent of electric power will probably reduce the power cost on an average by one half. The result will doubtless be the greater development of the existing mines and the encouragement of the search for new ones.... (*Spokesman-Review* 1 January 1903:B-1).

The following month, the General Electric Company contacted WWP regarding test results on the first of the two ATB-24-2250-300,4000 volt generators (Generating Units 4 and 5) which would power the above electrical needs. Wrote Blackwell:

> I have just been out in the Factory looking up the first machine which has been thoroughly tested and has turned out to be a remarkably fine generator; it is better than our guarantees in every respect. I give below the results of the test:

	ACTUAL	GUARANTEED
Regulation	6 1/4%	8%
Comm. Eff.		
Full Load	95.6%	95.0%
3/4 "	94.7%	94.0%
1/2 "	92.7%	92.0%
Temperatures:		
Magnetic and Electrical Parts	25°	40°
Bearings	36.5°	40°

> . . . . The generator will be shipped as soon as it can be painted and boxed, probably about the middle of next week. . . . The factory states that the second generator will come along three or four weeks later. . . . (WWP Papers, Series 7, Container 10, 28 February 1903, EWU Archives).

Meanwhile, work proceeded on the power transmission line to the Coeur d'Alenes, an activity which not only provided jobs but which also stimulated local manufacturing efforts. By July, seventy linemen, 10 groundmen, two foremen, and four wagons were at work stringing wire in Spokane alone, while outside the city, ca. 130 men and 30 teams were at work (*Spokesman-Review* 1 July 1903:5). At nearby Clayton, Washington, 40,000 duct feet of tiling was especially manufactured for the transmission line's underground conduits (ibid.). In addition, local contractor Fred Phair (to name but one individual who benefitted from the construction of the line) won the contract to build eight brick transformer buildings along the route of the line (*Spokesman-Review* 3 July 1903:7).

Completion of the transmission line marked the beginning of a period of intense hydroelectric development by WWP. In 1903 construction began on the Post Falls dam and power plant, WWP's first hydroelectric development outside of Spokane. Significantly, WWP engineers tapped into the transmission line to power construction of the Post Falls Plant, a circumstance made possible by the operation of Generating Units 4 and 5 (*Spokesman-Review* 13 September 1903:5). In addition to the Post Falls hydroelectric development, between 1903 and 1930 WWP built the Little Falls, Long Lake, and Upper Falls plants, and the Chelan Stations, and acquired the Oroville, Nine Mile, Dalkena, Lewiston, Grangeville, and Asotin Stations (Blewett 1990:21). With completion of the Cabinet Gorge facility in 1953, WWP nearly doubled its generating capacity, and in 1959 the 554 Mw Noxon Rapids dam was completed (Blewett 1990:43,49).

Development of this huge regional power network dwarfed the generating capacity of the increasingly antiquated Monroe Street Plant. The chief engineer's report for the year ending December 31, 1916, described and appraised the plant and its contents at that time. Buildings and fixtures consisted of the power house, valued at $100,159.00, and described as a "brick transformer room 20' x 62' x 32' station 62' x 94' x 32' and 116.5 x 41 x 25', boiler room 24 x 15 x 16'" (WWP Papers, "Report of the Chief Engineer to the Public Service Commission of Washington," 31 December 1916:np, Cage 297, WSU Archives, Pullman, Washington). Associated buildings included a blacksmith shop, oil house, "corrugated iron bldg., on wood frame, and small stone house," structures valued at $7,388.00 (ibid). The twin 40 1/2 inch Stillwell Bierce 4000-h.p. 350 r.p.m. 68 ft. head (the turbine units for generators 4 and 5) and one victor turbine were valued at $24,280.00 (Ibid). The Lombard Governors for the above units were appraised at $1,233.30 each (ibid.). Estimated cost of Generating Units 4 and 5 was $20,312.50 each (ibid.).

As early as 1931 WWP's chief engineer reported on the inefficiency of the Monroe Street Plant and recommended "redevelopment" of the site. Interestingly, as noted by the engineer, the extreme suitability of the site for power production, helped compensate for antiquated power generating equipment that otherwise would probably not have maintained adequate levels of performance for even a short time, let alone the years that Generating Units 4 and 5 had already served:

> The water turbines at this plant built as long ago as the units now in operation were not very efficient compared to present day standards. Many load tests have been made from time to time on these units. None of them show plant efficiencies over 50 per cent under the best conditions. The average day by day efficiency is much under this. . . . A load factor of practically 100 per cent can be maintained here because this is a stream flow plant connected with other plants in the system with ample pondage and further because of the plants very favorable position in the center of distribution ("General Report on Operating and Physical Condition Monroe Street Power Station, Spokane,Washington," May 1930:np, WWP Archives).

Today, redevelopment of the Monroe Street power site is at hand. The new low-profile power plant both illustrates the continuum of technological development of hydroelectric potential and the historic importance of the natural resource of the lower falls of the Spokane River and its energy production to the growth of a great regional power network.

DESCRIPTION OF UNDERTAKING

Hydroelectric Generating Units 4 and 5 are installed and currently producing power in the Washington Water Power Company's (WWP) Monroe Street Plant. The plant is located at the foot of the lower falls, near River Mile (RM) 74 on the Spokane River, in metropolitan Spokane, Washington. As part of the Monroe Street Hydroelectric Development, Federal Energy Regulatory Commission (FERC) Licensed Spokane River Project No. 2545, WWP plans to remove the downstream segment of the existing, exposed steel penstock, and demolish the existing Monroe Street powerhouse, which houses five turbine-generator units (including Generating Units 4 and 5). The existing powerhouse will be replaced with a low-profile powerhouse, housing a single turbine-generator unit. The new unit will be connected to the existing penstock via a new underground segment of steel penstock. The reconstruction project will replace the antiquated powerhouse infrastructure (turn of the century construction) and outmoded major generating equipment, installed 1903 to 1948. The new facility will increase annual energy production at the site from the present 45,000,000 kilowatt-hours (kWh) to a total of 117,000,000 kWh (WWP "Application for Amendment" 1990:5,8,13,E-03).

WWP will sell Generating Unit 4. Generating Unit 5 has been donated to the Henry Ford Museum in Dearborn, Michigan. Generating Unit 5 will become part of a permanent interpretative exhibit at the Ford Museum, illustrating early twentieth century hydroelectric development and innovative technology in the West. The museum plans to display the generating unit so that visitors can not only view the exterior of the equipment, but can also inspect the turbine unit from the inside by stepping into the turbine housing, thus fostering a better understanding of the equipment's purpose and function. Ancillary equipment that will be displayed along with Generating Unit 5 at the Ford Museum includes the two marble control segments for Units 4 and 5 (see photo WA-29-12), the oil circuit breaker for Unit 4 (see photo WA-29-13), and two control stands and hand wheels (see photo WA-29-13) used to regulate rheostats for field voltage control (John Bowditch, Curator of Industry, Ford Museum, interview with author, 3 July 1990).

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